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# Creative Thinking Skill Indicators in PjBL-based Reaction Rate Student Worksheets

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**Abstract:** This study aims to dig up informations about the suitability of creative thinking skill indicators in PjBL student worksheets on reaction rate material in the context of making liquid organic fertilizer from banana peels. The method used in this study is design research at the preliminary research stage and the development or prototyping stage. The preliminary research consisted of analysis of the literature review about project-based learning, creative thinking skills, and liquid organic fertilizer from banana peels. The development of prototyping stage consisted designing project-based student worksheets that designs to develop creative thinking skills and validation process or expert judgement by the validator about the designed worksheets. The results showed that there was a very good suitability (100%) bertween project-based stages and creative thinking skill indicators. There are three indicators of creative thinking skills that can be found in this worksheets, which is fluency thinking, flexibility thinking, and elaboration thinking. This shows that creative thinking skill indicators can be well formulated into project-based student worksheets on reaction rate material

**Keywords:** Creative Thinking Skill; Project-based Learning (PjBL); Reaction Rate; Student Worksheets

## Introduction

Learning in the 21st century is important deal with all the demands of human resource development. Teachers must be able to create human resources who master various skills in critical thinking, collaboration, communication, innovation, and creativity (Madhiyah et al, 2021). Creativity thinking skills is one part of creativity which involves developing ideas and products to problems. Williams in Munandar (1999) stated that creative thinking is an affective aspect which includes taking risks, feeling a challenge, curiosity and hunch, as well as cognitive aspects which include flexibilty, fluency, elaboration, and originality.

Research conducted by Purwati & Alberida (2022) shows that the creative thinking skills of 11st grade students are still very low. Student-centered learning processes are still difficult to run optimally because not all students are active in expressing questions, answers, and ideas. This leads to students inability to generate creative thinking skills in solving problems. Students are unfamiliar with creative thinking skills question (Amelia et al, 2018). Teachers have to apply some learning models that can train students' creative thinking skills (Rolia et al, 2018).

Project-based learning (PjBL) is a learning model that involves students in transferring knowledge and skills through a discovery process with a series of questions arranged in a project (Luthvitasari, 2012). This learning model can make students focus on problems to motivate and encourage them to deal with concepts and principles of knowledge directly as experienced experiences themselves (Desnylasari, 2016). PjBL-based learning media is proven to be able to improve student learning outcomes in the reaction rates subject (Simanjuntak. 2022). The PjBL model is also effectively used in reaction rate learning, where students are more active in going through all the PjBL stages (Muliaman, 2021). This learning model can improve students'

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creative thinking skills in chemistry subject (Fahmi & Wuryandini, 2020).

Reaction rate is one of the most difficult chemistry subjects for high-school students to understand, mostly because of its abstract characteristics (Kirik & Boz, 2012). Students are easily to have misconceptions in this subject (Supasorn et al, 2022). Kean and Middlecamp in Palisoa (2020) revealed that the abstractness of some chemistry concepts makes students required to imagine the existence of matter without observing and experiencing and it directly. Students' understanding of the concept of reaction rate is still low, this is much influenced by teachers who focus too much on theory and calculations. Students only memorized the theory rather than understand the concept and had difficulties in explaining some phenomena of factors that affect reaction rates (Marthafera et al, 2018). Teachers must focused on content learning and its context in students' life. Context-based chemistry learning used to improve the linkage of chemical concepts that are integrated into the real lives of students. In the present study of chemistry is much directed to relateto everyday life (Majid & Rohaeti, 2018).

The use of contextual-based worksheets is proven to be able to improve student learning outcomes and is effective in supporting student learning activities as a teacher's guide (Susiloningsih, 2015; Majid & Rohaeti, 2018). One of the contexts that can be used in learning chemistry is the making of liquid organic fertilizer from banana peels. The process of making liquid organic fertilizer from banana peels is carried out through a fermentation reaction with the help of $EM_4$ microorganisms (Nasrun, Jalaluddin, & Herawati, 2016). During the fermentation reaction, the volume of gas formed an be observed and calculated to determine the reaction rate. The topic of fermentation can be an interesting context for studying reaction rates with the application of the Project-based learning model (Sumarna, Permana, Anwar, & Hana, 2022).

Based on research conducted by Anidom et al (2015), teaching materials based on creative thinking skills can be used as teaching media in schools. Student worksheets on reaction rate subject can help developing student creative thinking skills of 11$^{th}$ grader (Putri & Mitarlis, 2015). Student worksheets are one of teaching material often used in the learning process. Student worksheets is a stimulus in learning that presented in writing by paying attention to the criteria of graphic media as a medium to attract students' attention (Fannie & Rohati, 2014). Student worksheets consistes a summary of questions or activities for students to do according to the steps that have been written (Khotimatuzzahara et al, 2021). Worksheets are commonly used in chemistry learning as learning media, one of which is reaction rate.

## Method

This study uses the design research model that implemented to design and develop interventions as solutions to complex educational problems (Plomp, 2013). In this study, two stages of design research were used. First, preliminary research stage consist of context and students' needs analysis, literature review, and development of a conceptual framework for research. In this first stage, an analysis of Chemistry Basic Competence is carried out for the reaction rate subject for 11$^{th}$ grade in the 2013 curriculum, and also analysis of literature studies related to PjBL by Mulyasa (2013), Creative Thinking Skills by Williams (Munandar, 1999), and Liquid Organic Fertilizer (LOF) from Banana Peels which will be used to design students' worksheets. The making of LOF for this worksheets uses the procedure for making LOF from bamboo shoots by Sumarna et al (2023). Second, the development of prototyping stage is carried out, where the PjBL-based students' worksheet is designed to develop students' creative thinking skills and the validation process or expert judgement by validators about the designed students' worksheets.

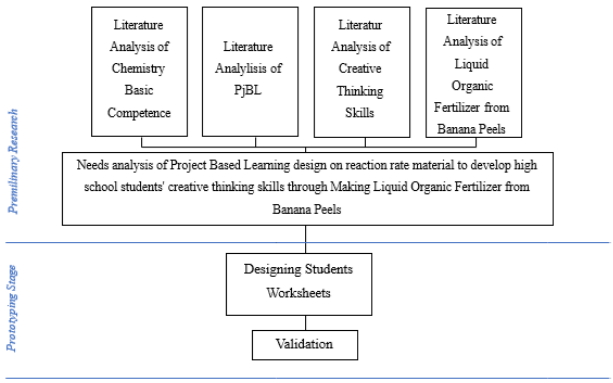


**Figure 1**. Research Scheme

The questionnaire method is carried out to collect information about assessments and suggestions related to the designed students worksheets according to five validators that is two chemistry education lectures and three high school chemistry teachers. The validator will determine whether there is relevance or suitability between the PjBL activities and creative thinking skills indicators. The validators will fill out the validation sheet by placing a check mark (✓) if they sees the relevance of both aspects, and a cross mark (✗) if they does not see the relevance of both aspects. The results of the assessment questionnaire data from the validators will be analyzed descriptively and quantitatively by calculating percentages and processed using the percentage formula according to Riduwan & Akdon (2013).

**Table 1:** Percentage of PjBL-student worksheets design eligibilty

| Percentage (%) | Category |
|---|---|
| 0-20 | Very Bad |
| 21-40 | Bad |
| 41-60 | Moderate |
| 61-80 | Good |
| 81-100 | Very Good |

## Result and Discussion

In the first stage, the results of analysis of basic chemistry competencies point 3.6 and 4.7 are competency achievement indicators as the basis for learning goals. Then, in the analysis of the literature review related to the PjBL model, it was determined that the syntax or implementation steps of the model applied were Esential Questions, Project Planning, Schedulling, Monitoring and Assessment, and Evaluation or Reflection (Mulyasa, 2013). The aspects of creative thinking skills that are applied are the formulation of indicators according to Williams (Mulyasa, 2013), namely Fluency Thinking, Flexibility Thinking, Original Thinking, and Elaboration Thinking.

Based on the results of the analysis of basic competencies and a review of the literature, PjBL-student worksheets was designed on the subject of reaction rate to develop creative thinking skills. At each PjBL stages, activities or questions are implemented that aim to develop students' creative thinking skills. The students' worksheets is divided into five stages according to the PjBL stages applied. The results of the design were then validated to see the suitability of the formulation of creative thinking skills indicators with PjBL-students' worksheets. The validation results are as follows (Table 2):

**Table 2:** The results of validating the suitability of the formulation of creative thinking skills and PjBL worksheets

| PjBL Activities on Student Worksheet | Creative Thinking Skills Indicators | The Percentage of Suitability between |
|---|---|---|
| (1) | (2) | (1) dan (2) |
| Students write down various information they find from the discourse about everyday phenomena on the worksheets | Flexibility Thinking | 100 |
| Students write down some questions that arise regarding everyday phenomena on the worksheets as questions to start the project | Fluency Thinking | 100 |
| Students plan projects according to the questions in activities 2 by discussing with their group | Flexibility Thinking<br>Elaboration Thinking | 100 |
| Students discuss with their groups to share project assignments and develop project work schedules | Flexibility Thinking<br>Elaboration Thinking | 100 |
| Students write down and report their progress, problems, and solutions experienced by the group during project work | Flexibility Thinking<br>Fluency Thinking | 80 |
| Students write down the results of discussions in answering questions in the worksheets based on their project results and reaction rate theory | Fluency Thinking | 100 |
| Students present the strengths and weaknesses of their project results | Fluency Thinking | 60 |
| Students reflect on their experiences about the project | Elaboration Thinking | 100 |
| Students answer questions, receive criticism and suggestions from other groups regarding the results of their presentations as an evaluation | Fluency Thinking | 100 |
| Students evaluate their project about why their experimental results may not be the same as reaction rate theory | Flexibility Thinking | 100 |
| | Average Percentage of Suitability | 82 |

Based on Table 2, there is a very good average fit (82%) in the suitability of the eleven PjBL activities on the students worksheets and the indicators of creative thinking skills.

According to Figure 2, the five validators that involved in this study are all agreed that most of the two aspects are suitable. There are three creative thinking skills indicators in this worksheet, fluency thinking, flexibility thinking, and elaboration thinking. The following paragraphs are the explanation of each PjBL stages and creative thinking skills in the designed worksheets with reaction rate subject.

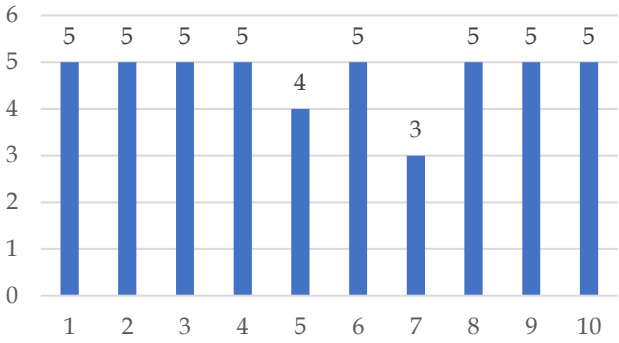


**Figure 2**. Graph of the results of the Validation of the Suitability of Crative Thinking Skills Indicators and PjBL-Activities in Students Worksheets by Five Validators

*First stage or Essential Questions*

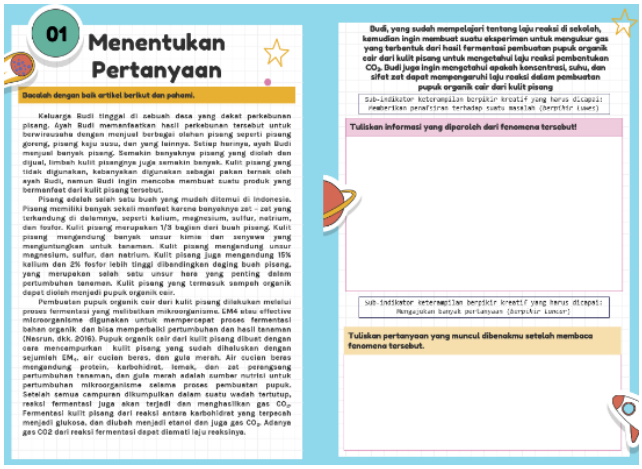


**Figure 3**. First Stage of PjBL in the Designed Reaction Rate Student Worksheets

In this stage, the teacher provides an article of information related to a phonomenon and an essential question. Students will express their ideas about project-based problem solving relatef to the given phenomenon. In this worksheets, the article is about Liquid Organic Fertilizer from Banana Peels as an example of the reaction rate phenomenon and two questions where students are asked to write down some facts or information they got from the article and questions or problems that arise in their minds after reading the article.

This activity can train students flexibility thinking skills where they need to see a problem or phenomenon from a different point of view and give their interpretation about the phenomenon, and also fluency thinking skills where students need to produce many answers and questions according to the phenomenon.

*Second stage or Project Planning*


**Figure 4.** Second Stage of PjBL in the Designed Reaction Rate Student Worksheets

In this stage, students plan a project to answer the questions or problem from the first stage. Students hold discussions with their group mates to plan everything they need for the project as tools, materials, and work steps. This activity can train flexibility thinking skills where students need to find many different alternatives regarding the selection tools and materials. Students also need to classify the tools and materials that are suitable for their upcoming project. Elaboration thinking skills can also be trained, where students have to add or detail the details of an object, idea, or situation to make it more interesting when reflecting on their experiences during the project work process.

*Third stage or Schedulling*


**Figure 5.** Third Stage of PjBL in the Designed Reaction Rate Student Worksheets

In this stage, students distribute project tasks among their group according to the work steps that have been planned and arrange a project work schedule. This activity can train flexibility thinking skills where students need to find alternatives in the division of tasks and project work schedules so that the project is completed according to the given time limit, and classify which group members can work on the work steps that need to be done at the same time. Elaboration thinking skills can also be trained, where students have to add or detail the details of an object, idea, or situation to make it more interesting when reflecting on their experiences during the project work process.

*Fourth stage or Monitoring and Assesment*

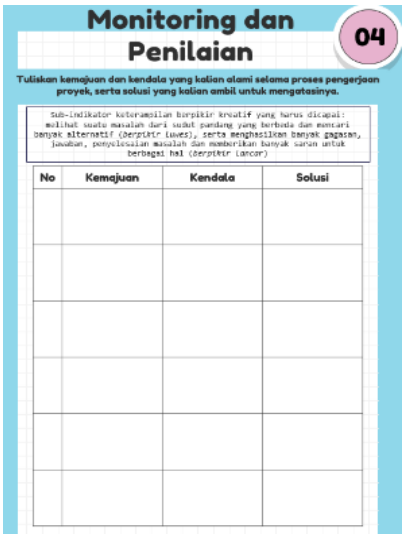


**Figure 6.** Fourth Stage of PjBL in the Designed Reaction Rate Student Worksheets

In this stage, students carry out their project according to plans, schedules, and division of tasks. Teacher regularly monitors students activities and progress through online chat. Students are asked to write down and report the progress, problems, and solutions experienced by the group during project work. This activity can train flexibility thinking skills, where students need to see a problem that occurs from a different perspective and need to find many alternative solutions and give consideration to situation encountered during project work. Students fluency thinking skills can also be trained, because students need to generate lots of ideas, answer, problem solving, or questions and provide ways with group mates during project work.

*Fifth Stage or Evaluation and Reflection*

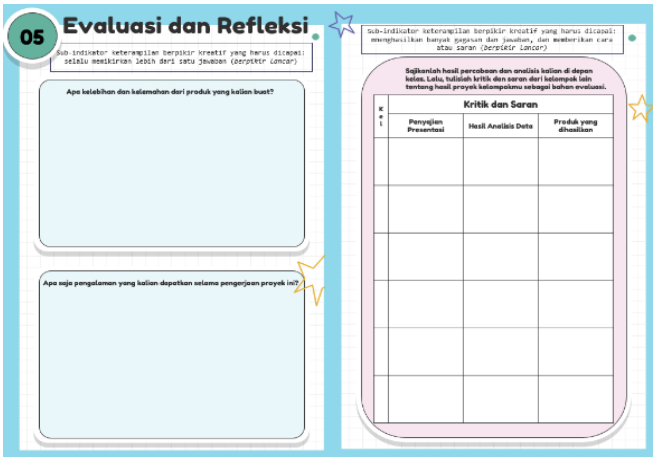


**Figure 7.** Fifth Stage of PjBL in the Designed Reaction Rate Student Worksheets

In this stage, students evaluate their projects that have been done and reflect on things that have been learned during project work. In this designed students worksheets, there are three questions about project results. Students are asked to write down the answers according to their project results. The results are then presented in front of the other groups. Students then are asked to presented the strengths and weaknesses of their project results, answer questions from other groups, and receive suggestions or criticism. This activity can train students fluency thinking skills, where students need to produce answers to questions posed by other groups, ask questions to other groups, provide advice to other groups regarding the obstacles they are experiencing, and also think of more than one answer to the questions or problems that arise, and can see the mistakes and deficiencies of the projects undertaken. Elaboration thinking skills can also be trained, where students have to add or detail the details of an object, idea, or situation to make it more interesting when reflecting on their experiences during the project work process.

Based on the explanation above, indicators of creative thinking skills can be formulated very well into the designed PjBL-based reaction rate students worksheets. Apart from being used to study reaction rate, this worksheets can train students' creative thinking skills. The results of project carried out by students can also be used for useful things, so students can learn more than one thing, such as the effect of liquid organic fertilizer from banana peels on plant growth. The results of this study are in line with the research conducted by Mukhlis et al (2023), Bashith et al (2019), Pasaribu et al (2023), and Wulandari et al (2021) where the development of students worksheets can be used to improve students creative thinking skills.

## Conclusion

Project-based learning worksheets on the subject reaction rate to develop students' creative thinking skills are designed based on the results of basic competency analysis and literature review regarding liquid organic fertilizer from banana peels as a learning context, project-based learning, and creative thinking skills. The results of the suitability validation of the aspects of the worksheets show that the designed worksheets have relevance between the PjBL stages and indicators of creative thinking skills with a percentage gain of 82% with very good criteria. Thus, PjBL-based reaction rate worksheets on are designed to contain activities that can train students' creative thinking skills, such fluency thinking, flexibility thinking, and elaboration thinking.

This worksheets are feasible to use in reaction rate learning.

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**Author Contributions**
The first author, Aisyah Tiara, contributed to designing research, creating research instruments, conducting research, analyzing data, and writing research articles. The second authors, Omay Sumarna and Sjaeful Anwar contributed to conceptualization of the research, validation of research instruments, guiding data analysis, and writing of research articles. All authors have read and agree to the published version of the manuscript.

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**Conflicts of Interest**
The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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